

Urban Stream Restoration

ASCE River Restoration Subcommittee on Urban Stream Restoration

Introduction

The modernization of society and the growth of urban centers have led to a subsequent decline in the quality of numerous watersheds and riverine ecosystems. In fact, despite the U.S. Environmental Protection Agency's able stewardship that has led to major strides in the improvement of the quality of natural streams over the last 30 years since the passing of the Clean Water Act, 40% of nation's waters are still categorized as *impaired*. Over the last two decades, there have been significant efforts to "restore" river systems to a more natural state thereby reversing the effects of development. To develop a focused initiative to promote river restoration efforts, the River Restoration Committee was formed in 1996 inside EWRI's Hydraulics and Waterways Council. Furthermore, as knowledge in the restoration field increased, it became apparent that there are distinct differences between urban and rural restoration projects. Urban stream restoration needed to be one of the core focuses of the committee because of the physical constraints imposed by development. This recognized need led the River Restoration Committee to form an Urban Stream Restoration Subcommittee in the summer of 2001. The purpose of this forum is to introduce the Urban Stream Restoration Subcommittee to the hydraulic engineering community by providing background information on urban stream restoration, share our committee goals, and encourage participation in committee activities.

River Restoration

To establish a uniform platform for discussion, it is important to define what we mean by urban stream restoration and how the restoration of urban streams differs from that of rural streams. As an initial step, let us first investigate what is meant by "river restoration."

According to *Webster's Dictionary*, the word restoration means, "... to go back to...." Therefore, river restoration would be the process of restoring a river system back to its natural state. However, this definition is very subjective depending on a person's views of preexisting conditions. For example, is the goal to restore the river to its 1950s condition or to its condition before settlement of the area? It is highly unlikely that we could restore a river system to presettlement conditions or that we would even accurately know the presettlement conditions of a river.

To eliminate some of the subjectivity, this group will use the definition put forth by the River Restoration Committee. The committee defines river restoration as "*An activity to environmentally protect and restore a river system to a more natural condition with sustainable features that enhance ecosystem values and biodiversity.*" Therefore, river restoration is the process of modi-

fying a disturbed river's physical, biological, or ecological conditions such that the post project river system is "healthier" and more stable than current river conditions. One of the keys in this definition is reference to a "more natural condition" and not necessarily returning a river to its natural state. The idea of a more natural condition becomes increasingly important in urban settings where existing infrastructure constraints make returning a river or stream to its natural state physically or economically impossible.

River restoration projects tend to be complex undertakings with successful projects requiring knowledge of watershed hydrology and land use, river mechanics, fluvial geomorphology, water quality, biology, and ecology. In addition to technical knowledge, successful river restoration projects also require designers/project managers to consider many social aspects including local demographics, recreation, economics, and culture.

The initial step in any restoration project is to determine the goals and objectives of the project based on the problems associated with the degraded system. Restoration project goals could include bank stability, water quality improvement, habitat enhancement, increased biodiversity, fishery enhancement, aesthetics, and recreation. In determining the project objectives, input from all concerned stakeholders should be considered. The list of stakeholders could be short or long depending on the location and size of the project, but might include landowners, municipal governments, policy makers, state-permitting agencies, special interest groups, land developers, planners, engineers, and researchers. In conjunction with determining the objectives of the project, a complete analysis of the existing system is required including geomorphic, hydrologic, and ecological assessments. Project objectives may need to be adapted after initial monitoring and the assessment of the system is complete. In fact, project objectives might change several times during the planning phase of the project. Finally, the arduous task of designing, permitting, and constructing the restoration project can begin. Post construction monitoring follows the construction phase and is a critical component of a project to give stakeholders a sense of success and reward for their efforts. All river restoration projects need to go through this planning, design, construction, and monitoring cycle.

Urban Stream Restoration

When describing restoration projects, frequently the terminology is urban *stream* restoration for urban projects and river restoration for rural projects. This is because a majority of urban restoration projects occur on smaller tributaries within urban environments while "larger" *river* restoration projects are undertaken in rural areas where the physical and political boundaries are less restrictive. In fact, using the term restoration is probably misleading for most urban projects.

Many urban streams are subject to numerous infrastructure constraints—including a political division of watersheds that is not based upon the course of the stream—and are so severely degraded that the concept of restoring them to anything resem-

bling a natural system is highly unlikely. Other common terms used in describing urban projects include urban stream enhancement, naturalization, landscaping, or rehabilitation in lieu of restoration. These terms frequently are more accurate in describing the objective of the project.

Urban streams differ from rural streams in many ways. For example, urban watersheds, with varying degrees of imperviousness, tend to have a wide variety of flow regimes ranging from high peaks with short duration to low (or even no) base flows. As the amount of impervious increases, the frequency of bankfull events increases while access to undeveloped floodplains decreases. Furthermore, bankfull indicators are more difficult to find in urban streams due to changing hydrologic conditions, degraded stream banks, physical changes to the streams (relocated sections), placement of man-made structures, and loss of riparian vegetation. In addition to hydrologic changes, urban streams tend to be more confined due to infrastructure. Frequent transportation crossings and utilities, particularly gravity sewer lines, are located in or across historic floodplains. Urban streams tend to have more structures such as culverts and bridges, and in some cases dams. These structures alter flow hydraulics and may further limit access to floodplains.

Changing sediment regimes in urban streams can also have dramatic effects on the form of a stream. Typically high sediment loads with finer particle sizes are produced in developing areas and enter the stream environment during storm events. The hydrologic changes caused by development can also destabilize an urban stream, which increases local bank erosion beyond its natural rate. Urban streams can also suffer from the other extreme when they are starved for sediment and thus erode the bed resulting in an incised channel. Impervious surfaces limit areas that can erode and stormwater detention ponds or reservoirs capture sediment-laden flows. An unbalanced sediment regime is caused from these changes in sediment transport rates and sediment properties. It is not unusual to find surfaces of extreme scour and other areas of rapid aggradation in the same urban river system, such that the stream morphology appears much different from a pre-disturbed condition.

Problems relating to water quality are also different in urban streams. Nonpoint source pollutants enter the receiving waters during storm events. In addition to increased sediment loads, storm flows flush nutrients, oils, and metals out of the atmosphere and off the pavement. Fecal coliform contamination is common in urban areas, especially if the wastewater treatment facilities cannot keep pace with community growth or many old septic systems are failing. In addition to chemical pollution, thermal pollution can cause habitat degradation. Heat from rooftops and blacktop pavements is absorbed by the rainfall and runoff and these heated waters enter channel systems. These problems can then be further exacerbated by thermal pollution from the loss of riparian vegetation and high width/depth ratios (low-base flows cover a wider area at a shallower depth).

Finally, urban communities have different concerns relating to streams than their rural counterparts. Public access, public safety, habitat, and aesthetics all enter the debate on what a "restored" stream should look like. Woody vegetation serves an important role in bank stability and in-stream and riparian habitat, however, some people prefer the aesthetics and perceived safety of an open, more park-like view.

For all of the above reasons, it is important to be diligent when planning urban stream projects. Examples of typical urban stream restoration projects include bank stabilization, re-meandering of artificially straightened reaches, channel day lighting of closed

conduit streams, dam and culvert removal, stream access, infrastructure protection, and habitat improvement.

Committee Goals

The Urban Stream Restoration Subcommittee's Mission Statement is "to advocate awareness and development of an engineering science and ecological basis for urban stream restoration." As such, the committee has three fundamental goals:

- To encourage and facilitate discussion on urban stream restoration through conference activities, workshops, publications, and public outreach. Sharing of information among a wide audience is crucial to the future of restoration activities and projects. Finally, providing a forum where stakeholders from various facets of the society can meet and provide their input to drive future policy measures.
- Advance the knowledge of fundamental physical, chemical, and ecological properties of urban streams by promoting collaboration and communication between researchers and practitioners. Increasing the technical knowledge of urban streams and watersheds will lead to the development of best management practices and sustainable designs to improve the water quality and ecological health of urban streams.
- Promote identified best management practices and sustainable designs while addressing infrastructure objectives and constraints found in urban areas.

Committee Activities

Municipalities, special interest groups, and watershed managers are faced with the need for scientifically, ecologically, and economically sound approaches to mitigate the impacts of urbanization in our cities' watersheds. Through the efforts of this committee, we hope to promote awareness of the interdisciplinary engineering science and ecological approaches for the planning, design, and monitoring of urban stream restoration projects. To meet our goals, the committee is currently engaged in several ambitious and exciting activities.

The most significant is cosponsoring (along with the Urban Streams Task Committee of the Urban Water Resources Research Council) an international symposium on the restoration and protection of streams with emphasis on urbanized and urbanizing streams. The symposium will be part of the EWRI sponsored World Water and Environmental Resources Congress, June 23–26, 2003, in Philadelphia. The symposium will consist of peer-reviewed papers and have separate proceedings from the rest of the conference. More information on the World Water and Environmental Resources Congress can be found on-line at <http://www.asce.org/conferences/> and we encourage your participation.

The committee is also working on several technical papers on the current state of research and practice with respect to urban stream restoration. These papers will be finalized in 2003 and will cover approaches and methodologies for urban projects across the country. Through these efforts, we will be able to determine not only what is the state of the art for urban stream restoration, but also what key knowledge gaps exist.

The River Restoration Committee would like to extend an invitation to those who are willing to contribute to one or more of our activities. We are also looking for new ideas on potential committee activities and collaboration with groups with similar interests. Please feel free to contact any of the officers listed below with your comments and suggestions:

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